J. Helminthol. Soc. Wash.
58(2), 1991, pp. 198–201

Abomasal Nematodes from White-tailed Deer (*Odocoileus virginianus*) in Maine[1]

LIHUA XIAO AND HAROLD C. GIBBS
Department of Animal, Veterinary and Aquatic Sciences, University of Maine, Orono, Maine 04469

ABSTRACT: Abomasa of 35 Maine white-tailed deer, collected from January to August during 1988, 1989, and 1990, were examined for nematode parasites. Six species of nematodes, *Mazamastrongylus odocoilei, Ostertagia mossi, Ostertagia dikmansi, Ostertagia ostertagi, Trichostrongylus askivali,* and *Trichostrongylus axei,* were recovered with prevalences of 100%, 94%, 29%, 2%, 14%, and 3%, respectively. Mean intensities of infection with adult worms were not high (max. 779) and highest levels were seen during the period April–July. Numerous, seasonally inhibited ostertagine larvae were also found. Prior to February, inhibition rates were very high (around 80%), but subsequently began to decrease. By May they were low (17%) and negligible in July and August, indicating a gradual resumption of development of inhibited larvae during the spring months.
KEY WORDS: nematodes, Ostertagiinae, *Odocoileus virginianus,* inhibited development, prevalence, Maine, *Mazamastrongylus odocoilei, Ostertagia mossi, Ostertagia dikmansi, Ostertagia ostertagi, Trichostrongylus askivali, Trichostrongylus axei.*

Species of the subfamily Ostertagiinae have been found to be widely distributed in white-tailed deer (*Odocoileus virginianus* (Zimmerman, 1780)) in the eastern parts of North America, from southern Florida (27°N lat.) to Barrie, Ontario (44°N lat.) (Becklund and Walker, 1968; Walker and Becklund, 1970; Prestwood et al., 1973; Baker and Anderson, 1975; Prestwood and Pursglove, 1981). Since ostertagiasis in domestic animals can present a serious problem, investigation of its occurrence in deer could be important to game management. Information on the distribution of ostertagine nematodes in white-tailed deer has begun to accumulate and some research (Baker and Anderson, 1975) has been done on the significance of inhibited development to their seasonal prevalence. The present research was aimed at studying the prevalence of Ostertagiinae species and their inhibited development in Maine in white-tailed deer.

Materials and Methods

Animals

Thirty-five abomasa from road-killed, adult white-tailed deer were collected over the months of January to August during 1988, 1989, and 1990 and were kept frozen until examined (usually within 2 wk). The animals were from 20 townships in central Maine.

Worm recovery

Worm recovery followed a modification of the method of Powers et al. (1982). After the abomasum was opened, its content was screened through 60- and 200-mesh sieves. All the screened material was collected and made up to a volume of 4,000 ml. A 10% sample was taken from each screening. Five percent formalin to a final concentration was added to preserve the sample for later worm counting. The abomasal mucosa was scraped and the scraping was digested in a jar for 4 hr at 40°C. For 100 g of mucosa, a digestion mixture of 5 g pepsin, 15 ml hydrochloric acid, and 500 ml water was used. After screening through a 200-mesh screen, 10% of the digesta was formalized for later worm counting.

Worm counting and identification

All counting was performed using a dissecting stereoscope. Parasites were then collected and preserved in 70% ethanol. Adult worms were identified using a compound microscope with the key of Becklund and Walker (1968) and species descriptions by Davidson and Prestwood (1979), Rickard and Zimmerman (1986), and Dunn (1965). Inhibited larvae were identified by the descriptions of Baker and Anderson (1975). Representative specimens have been deposited in the United States National Museum Helminthological Collections, Beltsville, Maryland and assigned accession numbers 81805 through 81808.

Results

Mean monthly worm counts for the 35 deer are shown in Table 1. Six species of worms were found, 4 of them belonging to the subfamily Ostertagiinae. All of the deer had worms in their abomasa, although the total worm counts were generally not very high (maximum 2,419). Highest numbers of worms were found during the winter and spring months (January–April). Of the deer, 97% were infected by more than 1 species, 40% were infected by 3 species, and 3% by 4 species of parasites. The 6 species and their

[1] Published as Maine Agricultural Experiment Station Publication No. 1530.

prevalences were: *Mazamastrongylus odocoilei* (Dikmans, 1931) (100%), *Ostertagia mossi* (Dikmans, 1931) (94%), *O. dikmansi* (Becklund and Walker, 1968) (29%), *O. ostertagi* (Stiles, 1892) (3%), *Trichostrongylus askivali* (Dunn, 1964) (14%), and *T. axei* (Cobbold, 1879) (3%). The most prevalent and dominant species were *M. odocoilei* and *O. mossi*.

Seasonal inhibition of the ostertagine worms was also observed. For most deer, during the winter months (January–March), numbers of inhibited larvae were higher than those of adults. As shown in Table 1, before February the inhibition rates were high (around 80%). After this, the inhibition rates began to decrease and by May the inhibition rate was low (17%) and negligible during July and August. As the proportion of inhibited larvae decreased, numbers of adult and developing ostertagines increased. Highest numbers of adult worms were seen during the period of April–June.

Discussion

The most prevalent of the 6 species of nematodes found in Maine white-tailed deer were *M. odocoilei, O. mossi,* and *O. dikmansi. Ostertagia ostertagi* and *T. axei* are mainly parasites of cattle and each was found in only 1 deer; therefore, they represent accidental parasites of the deer. Their presence in white-tailed deer has previously been reported (Walker and Becklund, 1970; Prestwood et al., 1973). *Ostertagia ostertagi* has been reported as causing clinical disease in 1 white-tailed deer (Conti and Howerth, 1987). *Trichostrongylus askivali* was originally reported as a parasite of red deer in Scotland (Dunn, 1965). Its presence in white-tailed deer was reported by Prestwood et al. (1973) in the southeastern United States, but it has not been reported in northern parts of North America before. Its distribution may thus be wider than previously considered. Another common species in the southeast, *Mazamastrongylus pursglovei* (syn. *Apteragia pursglovei*) (Davidson and Prestwood, 1979), was not found in Maine.

The northernmost point where species in the subfamily Ostertagiinae have previously been reported in white-tailed deer was Barrie, Ontario (44°N lat.) (Baker and Anderson, 1975). The present report thus confirms that members of the Ostertagiinae are present in colder areas; in this instance the northernmost location was Greenville, Maine (45.5°N lat.). Ostertagines in white-

Table 1. Mean monthly worm recovery from deer abomasa.

Month	No. of deer	Ostertagiinae								Trichostrongylus		Total worms
		M. odocoilei	*O. mossi*	*O. dikmansi*	*O. ostertagi*	Adults	LL4*	EL4†	Inhibition (%)	*T. askivali*	*T. axei*	
Jan.	3	175	52	0	0	279	0	919	80.8	0	0	1,146
Feb.	4	467	93	0	0	560	43	1,811	76.5	5	0	2,419
March	7	157	41	12	0	210	11	545	67.3	4	0	770
April	8	409	268	62	14	753	199	960	46.9	1	0	1,913
May	3	642	121	13	0	776	70	153	17.2	3	0	1,002
June	5	624	79	20	0	723	47	68	10.1	8	38	884
July	3	592	84	0	0	676	33	0	0.0	0	0	709
Aug.	2	289	16	0	0	305	35	0	0.0	0	0	340

* Late fourth-stage larvae.
† Early fourth-stage larvae.

tailed deer appear to be, therefore, widely distributed in North America. Unlike reports from other regions, *O. mossi* was much more common in Maine, with a prevalence of 94%. In the Southeast, Prestwood et al. (1973) reported a prevalence of 20%, while in Ontario, Canada, Baker and Anderson (1975) reported a prevalence of 66%. Interestingly, *O. dikmansi* was found only between March and June, together with *O. mossi*, in Maine.

Baker and Anderson (1975) reported that there was a seasonal prevalence of inhibited larvae of ostertagine species in white-tailed deer in Long Point, Ontario. They recovered numerous inhibited, early fourth-stage larvae during winter and early spring, and a few in July and August. The present research is in agreement and showed that inhibited development of Ostertagine nematodes also occurs in Maine white-tailed deer. Inhibition rates were very high before February, then decreased gradually. Resumption of development of inhibited larvae in bovine ostertagiasis in different geographical locations is either spontaneous and synchronous or unspontaneous and unsynchronous (Armour and Ogbourne, 1982). This may be the case in deer ostertagiasis. At Long Point, Ontario, Baker and Anderson (1975) found that except in May, most worms recovered from deer were either early fourth-stage larvae or fully developed adults, a sign of synchronous resumption of development. However, since developing larvae were found frequently in Maine deer throughout the spring, this implied a gradual or unsynchronous resumption of inhibited larval development in the worms in this region. In Maine cattle, it was found that inhibited larvae of *O. ostertagi* resume their development gradually (Gibbs, 1988).

The highest inhibition rate we observed (81%) was higher than that (65%) obtained by Baker and Anderson (1975). Inhibited development may thus be a widespread event in deer ostertagine nematodes. The studies in Ontario and Maine are in agreement with the results obtained from bovine ostertagiasis of north temperate regions of North America (Gibbs, 1988), with occurrence of inhibited development in winter. In south temperate regions, studies of seasonal prevalence of ostertagine worms in adult deer showed high adult worm burdens in summer and fall (Eve and Kellogg, 1977), suggesting that the situation in deer from these areas is similar to that in bovine ostertagiasis (Williams and Knox, 1988) from that region, with the probable occurrence of inhibited development in summer.

Acknowledgment

We thank the personnel of the Maine Department of Inland Fisheries and Wildlife, who submitted the deer abomasa.

Literature Cited

Armour, J., and P. Ogbourne. 1982. Bovine Ostertagiasis: A Review and Annotated Bibliography. Commonwealth Agricultural Bureaux, England. 93 pp.

Baker, M. R., and R. C. Anderson. 1975. Seasonal changes in abomasal worms (*Ostertagia* spp.) in white-tailed deer (*Odocoileus virginianus*) at Long Point, Ontario. Canadian Journal of Zoology 53: 87–96.

Becklund, W. W., and M. L. Walker. 1968. *Ostertagia dikmansi* sp. n. (Nematoda: Trichostrongylidae) from deer, *Odocoileus virginianus*, with a key to the species of medium stomach worms of *Odocoileus* in North America. Journal of Parasitology 54:441–444.

Conti, J. A., and E. W. Howerth. 1987. Ostertagiosis in a white-tailed deer due to *Ostertagia ostertagi*. Journal of Wildlife Diseases 23:159–162.

Davidson, W. R., and A. K. Prestwood. 1979. *Apteragia pursglovei* sp. n. (Trichostrongyloidea: Trichostrongylidae) from the white-tailed deer, *Odocoileus virginianus*. Journal of Parasitology 65:280–284.

Dunn, A. M. 1965. *Trichostrongylus askivali* (Nematoda: Trichostrongylidae). A full description. Journal of Parasitology 51:57–59.

Eve, J. H., and F. E. Kellogg. 1977. Management implications of abomasal parasites in southeastern white-tailed deer. Journal of Wildlife Management 41:169–177.

Gibbs, H. C. 1988. The epidemiology of bovine ostertagiasis in the north temperate regions of North America. Veterinary Parasitology 27:39–47.

Powers, K. G., I. B. Wood, J. Eckert, T. Gibson, and H. J. Smith. 1982. World Association for the Advancement of Veterinary Parasitology (W.A.A.V.P.) guidelines for evaluating the efficacy of anthelmintics in ruminants (bovine and ovine). Veterinary Parasitology 10:265–284.

Prestwood, A. K., F. A. Hayes, J. H. Eve, and J. F. Smith. 1973. Abomasal helminths of white-tailed deer in southeastern United States, Texas, and the Virgin Islands. Journal of the American Veterinary Medical Association 163:556–561.

———**, and S. R. Pursglove, Jr.** 1981. Gastrointestinal nematodes. Pages 318–350 *in* W. R. Davidson, F. A. Hayes, V. F. Nettles, and F. E. Kellogg, eds. Diseases and Parasites of White-tailed Deer. Southeastern Cooperative Wildlife Disease Study. 458 pp.

Rickard, L. G., and G. L. Zimmerman. 1986. First report of *Ostertagia kolchida* (Nematoda: Trichostrongyloidea) from North America. Proceedings

of the Helminthological Society of Washington 53: 136–138.
Walker, M. L., and W. W. Becklund. 1970. Checklist of the internal and external parasites of deer, *Odocoileus hemionus* and *O. virginianus,* in the United States and Canada. Index-catalogue of Medical and Veterinary Zoology Special Publication No. 1, United States Department of Agriculture. 45 pp.
Williams, J. C., and J. W. Knox. 1988. Epidemiology of *Ostertagia ostertagi* in warm temperate regions of the United States. Veterinary Parasitology 27: 23–38.

Student Presentation Competition Results

The Second Student Presentation Competition, sponsored by The Helminthological Society of Washington, was held at the 618th Meeting of the Society at the Walter Reed Army Institute of Research on 13 March 1991.

John Hawdon, a graduate student in the Department of Parasitology, School of Veterinary Medicine, University of Pennsylvania, captured the First Place award for his paper, "Reduced glutathione induces feeding by *Ancylostoma caninum* infective larvae." Mr. Hawdon received $300 from the Society and a 1-yr subscription to the *Journal of Parasitology* from the American Society of Parasitologists. If his paper is accepted for publication in the *Journal of the Helminthological Society of Washington,* page charges will be waived.

James Higgins, a graduate student in the Department of Immunology, School of Hygiene and Public Health, Johns Hopkins University, received the Second Place award of $200 for his presentation, "Development of *Brugia malayi* in resistent strains of *Aedes aegypti.*"

Victor Apanius, a graduate student in the Department of Biology, University of Pennsylvania, captured the Third Place award of $100 for his presentation, "Chronic blood parasitism, immunity and reproduction in wild birds."

Nancy Briscoe, an undergraduate student in the Department of Biological Sciences, Marshall University in West Virginia, presented an interesting study on "Population dynamics of *Orchopeas leucopus* (Siphonaptera: Ceratophyllidae) and *Epitedia wenmanni* (Siphonaptera: Hystrichopsyllidae) from the white-footed mouse, *Peromyscus leucopus,* in Mason Co., West Virginia."

Robert Maxe, a graduate student in the Department of Parasitology, School of Veterinary Medicine, University of Pennsylvania, gave his presentation on "The application of the factorial experimental design in the investigation of the impact the nematode *Parelaphostrongylus tenuis* has on the fecundity of the intermediate host *Triodopsis albolabris.*"